

Aus der Chirurgischen Universitätsklinik Basel
(Direktor: Prof. Dr. R. Nissen)

Unter Leitung von PD Dr. L. Eckmann

SURGICAL MANAGEMENT OF SPONTANEOUS PNEUMOTHORAX

INAUGURAL-DISSERTATION

zur

Erlangung der Doktorwürde
der Medizinischen Fakultät
der Universität Basel

vorgelegt von

Marvin Berger

von New York

ARNAUD DRUCK BERN 1959

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Genehmigt von der Medizinischen Fakultät auf Antrag von
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Tag der Promotion: 1. Dezember 1959.

SPONTANEOUS PNEUMOTHORAX

I. Introduction

Any condition which tends to decrease proper pulmonary function must be properly and promptly treated. One of the conditions which has continued to be a problem is spontaneous pneumothorax. This paper will take into consideration some of the therapeutic methods currently employed, including the technics used at the Surgical University Clinic, Basel, Switzerland. It should be borne in mind however that a majority of these patients are treated successfully by conservative methods, and are never seen by the surgeon. Therefore those cases which are resistant to treatment or of chronic nature will be considered.

II. Classifications

Spontaneous pneumothorax, the sudden unprovoked entrance of air into the pleural cavity, may be divided into several groups according to cause:

PRIMARY SPONTANEOUS PNEUMOTHORAX

- (1) A large and important group is composed of those which occur in apparently healthy persons who display no clinical evidence of pulmonary disease. In this group, it is assumed that the cause is the rupture of an insignificant emphysematous bulla, which may or may not be associated with previous inflammatory lung disease.
- (2) Closely related to group (1) are the cases associated with recognizable emphysematous or cystic changes of various sorts in the lung. In generalized emphysema, pneumothorax is rarely observed, probably because the intrapleural pressure in such cases is said to approach atmospheric. Patients who have localized emphysematous changes, for instance associated with obsolete fibrotic or calcified tuberculous lesions, may develop pneumothorax; localized cystic lung changes may give rise to pneumothorax; and in the rare condition of "honeycomb lung" which is characterized by the presence of multiple cysts throughout the lungs, spontaneous pneumothorax is a frequent complication.

- (3) Cases of asthma can cause this condition.

SECONDARY SPONTANEOUS PNEUMOTHORAX

- (4) Spontaneous pneumothorax may occur in the course of pulmonary tuberculosis.
- (5) Pulmonary suppuration may give rise to spontaneous pneumothorax by ulceration of intrapulmonary abscesses into the pleura; and occasionally pleural empyema ulcerates into the lung, giving rise to a pneumothorax.
- (6) Pneumonias, especially of the bronchopneumonic type and in infants, may give rise to spontaneous pneumothorax.

III. Diagnosis

The symptoms which occur in people with no previous pulmonary history are variable, but the main symptoms are sudden chest pain, cough, dyspnea, and less frequently, cyanosis and shock. The most marked symptoms are caused in association with tension pneumothorax, in which case a valvular communication between the pleura and a broncho-pulmonary air-space allows air to enter the pleura during inspiration, but prevents it from leaving during expiration.

The physical signs of pneumothorax vary greatly with its size and according to the presence or absence of liquid effusions. The constant sign is weakness or absence of breath sounds on the affected side of the chest. A small pneumothorax in a free pleural space may produce no other sign than weakness of the breath sounds. A rather large pneumothorax will produce absence of breath sounds, a change in percussion note, and slight displacement of the heart and mediastinal organs towards the opposite side. A large pneumothorax will produce hyper-resonance on percussion, cardiac shift and tracheal deviation all to the opposite side. The affected hemithorax will be observed to move less. The presence of liquid, either clear effusion, blood, or rarely pus, produces additional signs. This is true especially in large pneumothoraces when succussion splash can be elicited.

Radiologically, pneumothorax is readily recognizable by a fading out of the normal lung markings with decreased expansion of the rib cage on the affected side, while the outline of the collapsed lung is visible. Sometimes a mediastinal shift takes place with corresponding displacement of the chest structures.

Fluoroscopy, in addition, may sometimes show a paradoxal movement of the diaphragm.

To the differential diagnosis comes myocardial infarction, pulmonary infarction, pericarditis, pleurisy, pancreatitis, and various abdominal disorders.

IV. Treatment

Therapy may be instituted as follows:

A. Conservative Therapy:

This includes bed rest alone, or with single or multiple needle aspirations if necessary to remove air or fluid from the pleural cavity, or when necessary, the introduction of an intercostal catheter attached to a water drainage system with suction.

B. Operative Therapy:

- a. Either open thoracotomy (operation) or closed thoracotomy (local incision and introduction of instruments into the pleural cavity), with the addition of substances which will cause chemical pleural irritation and adhesions.
- b. Open thoracotomy which includes surgical excisions of cysts, bullous blebs, lobes, and even lungs.
- c. Newer techniques such as parietal pleurectomy, pleural scrub, and mechanical irritation of the pleura.

(In addition, a, b, and c can be used with an intercostal catheter attached to an underwater drainage system with suction.)

In short, conservative treatment is more applicable to those patients classified in groups (1) - (3) (or Primary Spontaneous Pneumothorax).

As mentioned, operative therapy has been proposed in several forms. The first method used in large scale was the formation of artificial sterile pleuritis in order to obtain the occlusion of the pleural cavity.

To achieve this, various substances have been used. The discovery goes back to 1901 when Spengler reported on the effects of a hypertonic solution of glucose injected into the pleural cavity. Later he advocated the use of a solution of 0,5 % of silver nitrate. Bethune (1935) proposed poudrage of the pleura with iodized

talc, and Chandler (1939) described results of the injection of a solution of germol in olive oil. Also in 1939, Hannels and Steinburg used iodized oil in glucose solution. Stute (1937) tried talc insufflation. Mariati and others (1937) evaluated guaicol, blood, iodoform, and lip iodol. Brock (1948) and Curti (1950) again elaborated on the use of silver nitrate.

These different substances by their action fall into two groups:

- (1) Chemical irritants of the pleura, like blood, glucose, oils and silver nitrates which act like a caustic agent with actual destruction of tissue, thereby producing severe pleuritic reaction.
- (2) Agents such as talc poudrage producing the well known talc granuloma. In addition, a few more substances such as kaolin, (introduced by Maxwell in 1954) and varidase (introduced by Kallqvist in 1955) were used to produce an obliterative pleuritis.

According to Emerson, Bethune, and Beardsley, artificial pleuritis is an efficient method, especially in the form of talc poudrage. However, disadvantages may be mentioned with this method:

- a. Pain may result for a long time, for months and even years.
- b. If large emphysematous bulla are present, they will not be reduced and this space will not be replaced by active, normal lung tissue. In addition, re-occurrences are still possible.
- c. The formation of talc granuloma is quite common, and talc emboli are possible.

The resection methods are somehow too disproportional and too disabling as compared with the character of the disease. In other words, lobectomies and pneumectomies can be out of proportion to the existing pathology and the result would be a permanent loss of active lung tissue without necessity, which might further embarrass an already insufficient pulmonary aeration.

These points led Nissen in 1944 and later Naclerio to propose another type of operation. With this technic, no lung tissue is removed nor is the pleura in any way irritated. The defective area, regardless of the size, is exposed by open thoracotomy and sutured over. With small emphysematous areas, sutures are placed around in the healthy tissue, so that when the sutures are drawn together, this defective part is submerged into healthy lung tissue. With large or cystic like bulla, the supplying bronchus may be tied off with something like tobacco string sutures. (See Figures 1-6. These illustrations are similar to those used by Nissen in describing this method.) Now the sewn over area and the lung are

tested for air leaks. This is done by expanding the lung under positive pressure and submerging it in saline solution which has been introduced into the chest cavity. Any escaping air bubbles can be rapidly detected in this way. This technique is used as the standard operational procedure at the Surgical University Clinic, Basel.

Recently other methods have been reported, namely the pleural scrub (Beardsley), and parietal pleurectomy (Gaensler and - quoted from Eckmann - Thomas.)

V. Discussion of Results

At the Surgical University Clinic, Basel, conservative therapy, which includes bed rest alone, needle aspiration, or intercostal catheter draining systems, is prescribed for all the patients with spontaneous pneumothorax before any operative procedure is taken into consideration. If this type of therapy fails after a two to three week trial period, or if this patient's condition continues to deteriorate, other procedures are considered.

In comparing Tables I and III, which include the results obtained from records of the patients treated conservatively at the Surgical University Clinic, Basel against those obtained by several authors concerning patients from various institutions in the United States, we see that the rate of expansion using the intercostal catheter system is approximately the same. In addition, the expansion is usually complete and without complications. The time required for re-expansion to take place with bed rest alone is quite variable as can be readily ascertained. One explanation behind this may be that different institutions observe different rules in regards to treating patients with bed rest alone. For example, Briggs and Rubel advocate that when less than 25 % of the lung is collapsed, bed rest alone should be the treatment of choice. With degrees of collapse above this limit, more active means of therapy, such as needle aspirations and the intercostal draining systems are employed. However, other hospitals do not necessarily observe any rule and apply any one of the above mentioned methods, regardless of the degree of collapse.

The conservative approach is generally a good one, however, in certain cases it may be impossible to expand the lung at all. This is usually the case when a large communication between the broncho alveolar system and the pleura is present, and the closure of this space is prevented by adhesions, fibrosis, or calcification. In the group of patients from the Surgical University Clinic, we see that in treating all of the fifteen patients conservatively, six failed to respond



Figure 1

The emphysematous area is exposed and the sutures are prepared



Figure 2

The sutures are drawn together and tied off, thereby embedding the defective tissue

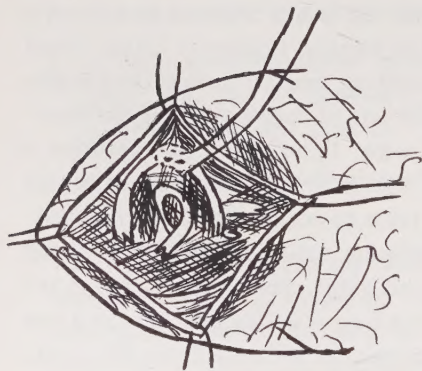


Figure 3

Tobacco string suture of the cyst closes off the bronchial communication

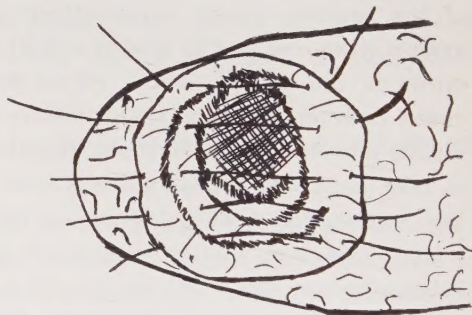


Figure 4

The cyst is reduced with an internal series of sutures



Figure 5
External sutures of the refolded lung tissue are prepared



Figure 6
The sutures are drawn together and tied off.

and they were then treated with the described suture type operation. From Table II, we see that all the patients lungs expanded in a short length of time, average four days. The degree of expansion ranged from subtotal to complete, without major complications.

In Table IV, is a list of various operative procedures along with the authors advocating them. Other procedures such as parietal pleurectomy, pleural scrub, mechanical irritation, plus the use of kaolin and varidase to produce a septic pleuritis are also chartered. The degree of expansion in most cases is complete. In some of the technics, such as with the use of glucose and kaolin, severe pain and fever were reported. Shefts and others discontinued the use of glucose instillation because the pain was too severe. The use of talc insufflation has well known draw-backs.

The use of more drastic procedures like wedge resection, lobectomies and pneumectomies have some use, but it is generally admitted these methods are too radical and the creation of a pulmonary cripple cannot be disregarded easily.

The following represents fifteen brief case histories from which this material was gathered:

Case Reports

CASE HISTORY No. 1

W. M., a 28 year old male with no past pulmonary history, awoke the morning of his admission with a slight cough. Upon standing up, he felt a strong, sharp pain over his chest, and he could not breathe.

Hospital examination revealed a healthy young male with guarded breathing. The patient complained about continuous pains over the entire chest.

Local Status: Thorax. The expansion on the right side was limited with hyper resonance to percussion over both lungs, however the right lung was more resonant than the left. There were no audible breath sounds upon auscultation on the right side.

Diagnosis: X-ray reports revealed a complete right sided spontaneous pneumothorax.

Therapy: The patient was treated conservatively and x-ray follow-ups showed continuous lung re-expansion. Eight days later the patient was discharged to home care.

Discharge Status: The patient felt completely well, however, x-ray revealed the lung was not yet fully re-expanded.

CASE HISTORY No. 2

K. W., a 25 year old male, with no past pulmonary history, was admitted with a diagnosis of possible acute abdomen. The patient awoke early on the day of admission with pains in the epigastrium which radiated into the back and he also experienced difficulty in breathing.

Hospital examination revealed that the patient was in good physical health, complaining of severe "stomach pains".

Local Status: Thorax. Examination here was completely negative. The patient was given a fluoroscopic examination, at which time a diagnosis of right sided pneumothorax was made.

Diagnosis: Subsequent x-rays revealed a complete collapse of the right lung.

Therapy: A hundred cc. of air was removed from the pleural cavity and an intercostal drain with suction was prescribed. The patient felt better immediately, and his condition improved. After seven days of suction, the drains

were removed. At this time the patient asked to be released from the hospital to continue treatment at home.

Discharge Status: The x-ray report still showed that the middle lobe had not yet completely re-expanded. The patient was symptomless.

CASE HISTORY No. 3

F. W., a 23 year old lieutenant in the Swiss army with no past pulmonary history, while driving his auto, suddenly felt a sticking pain in his right shoulder. He experienced immediately a breathing difficulty and was forced to seek bed rest. The x-ray report taken at the military hospital showed a complete pneumothorax on the right side. A trial period of bed rest was prescribed and the patient was then transferred to this hospital.

Hospital examination revealed that the patient appeared completely healthy and expressed no complaints.

Local Status: Thorax. The findings upon physical examination were minimal. The right thorax half was a little flatter. Percussion and auscultation were almost normal.

Diagnosis: The x-ray revealed a partial pneumothorax on the right side with possible upper lobe adhesions.

Therapy: With bed rest the lungs completely expanded after twelve days.

Discharge Status: The patient's condition was excellent and the final x-ray was normal.

CASE HISTORY No. 4

E. S., a 38 year old female with no past pulmonary history, while walking in the street suddenly experienced a coughing attack and dyspnea. For the next days, she had continuous coughing with difficulty in breathing. The patient sought medical attention at this time and was diagnosed as having had a pneumothorax on the right side, and was treated ambulant with repeated chest taps. Since these attempts failed, she was admitted to the hospital.

Hospital examination revealed the patient to be in good health and relatively symptomless.

Local Status: Thorax. Percussion and auscultation revealed hyper resonance over the right lung, with complete absence of breath sounds.

Diagnosis: X-ray still showed a complete collapse of the right lung.

Therapy: An intercostal drainage system was installed and the lung expanded completely in one day. The drain was kept in place for only two days. As a complication, the patient developed a thrombophlebitis and was treated for such. The patient was discharged eight days after admission.

Discharge Status: X-ray showed complete expansion of the lung. The patient still complained of slight exertional dyspnea.

CASE HISTORY No. 5

P.B., a 30 year old male with no past pulmonary history awoke early on the morning of the day of his admission with headache, dizziness, shortness of breath and pains in his back on the right side.

Hospital Examination upon admission showed that the patient was gray cyanotic. He was orthopneic and covered with sweat. His lips and extremities were slightly cyanotic.

Local Status: Thorax. Left thorax half expanded more than the right. There was complete absence of breath sounds, decreased respiratory excursions, and hyper resonance over the right lung.

Diagnosis: X-rays showed a complete collapse of the right lung. The right sinus phrenico-costalis was free from pleural effusion.

Therapy: Sixty cc. of air were removed by pleural tap. Then in the second intercostal space, in the medioclavicular line, an incision was made and an intercostal drain was placed inside. This tube was attached to a standard drainage system and suction was applied. The patient felt better immediately after this procedure. The following x-rays showed incomplete lung expansion, especially in the lower lobe. About nine days later, the lung was almost completely expanded, however there were still two small areas of atelectasis in the lower lobe. Approximately eleven days after admission, the patient was discharged.

Discharge Status: X-ray still showed these slight atelectatic areas but the patient showed no signs of dyspnea or of other symptoms.

CASE HISTORY No. 6

P.W., a 31 year old male with no previous history of pulmonary disease, began to have trouble with his lungs about eight months prior to hospitalization. At this time, he had sudden sharp sticking pains in the left posterior axillary line when he walked upstairs. The patient since this time had repeated episodes of dyspnea and pain, however he did not seek medical advice. On the day of admission,

while returning from an auto trip, he developed sudden retro-sternal pain and difficulty in breathing.

Hospital examination showed that the patient was in no acute respiratory distress, however, there was slight cyanosis around the lips and mouth.

Local Status: Thorax. Narrow and symmetrical in this area, with hyper resonance and decreased breath sounds over the right lung area.

Diagnosis: X-ray revealed a total collapse of the right lung. The right sinus phrenico-costalis was filled with fluid.

Therapy: An intercostal catheter was introduced into the fourth intercostal space and suction was applied. There was immediate expansion of the lung. The drains were removed, and the patient was discharged nine days later.

Discharge Status: The x-ray revealed a complete expansion. The patient was symptomless and without complaint.

CASE HISTORY No. 7

K. S. , a 43 year old female, suddenly on the morning of admission, felt a sticking pain in the right side of her chest. At this time, she developed a cough, shortness of breath, and pain. The patient never complained of any previous chest ailments.

Hospital examination revealed a patient in no acute distress, with relatively few complaints.

Local Status: Thorax. There was hyper resonance to percussion and lack of breath sounds on the right side. There was no mediastinal shift.

Diagnosis: X-ray showed the whole right lung was collapsed to the hilus. In the right sinus phrenico-costalis, there was a small effusion.

Therapy: A needle was placed into the pleural cavity, and 1.5 liters of air were removed. Two hours later a fluoroscopic examination pictured the lung as being three fourths expanded. Three days later x-rays revealed that the lung was almost completely expanded and there were remains of a slight pleural effusion. Nine days after the beginning of therapy, the lung was completely expanded and the patient was discharged exactly two weeks after hospital admission.

Discharge Status: The patient felt perfectly well and had no complaints. The final x-ray revealed an almost completely expanded lung with a small effusion in the sinus.

CASE HISTORY No. 8

G. M. , a 29 year old male with no past history, while playing football, suffered an injury, at which time he found it difficult to breathe. The patient was taken to the hospital.

Hospital examination showed an extremely dyspneic and cyanotic patient.

Local Status: Thorax. The respiratory excursions were limited on the right side. There was complete absence of breath sounds here too. No mediastinal shift was present.

Diagnosis: X-ray revealed a completely collapsed right lung.

Therapy: An intercostal catheter was introduced into the pleural cavity and suction was applied, however, after eleven days the lung did not expand. The patient was then operated on. An open thoracotomy disclosed that at the apex of the right upper lobe many small emphysematous bulla were present. This whole area was sutured over. The lung was then inflated under positive pressure, in order to test for an air leak. The chest was then closed. The follow-up x-rays showed that the lung was completely expanded in six days, and the patient was discharged ten days after the operation.

Discharge Status: The final x-ray showed two small remaining areas of pneumothorax. The diaphragm on the right side was a finger width higher than the left, and fluoroscopy showed this side to be motionless. The patient had no complaints.

CASE HISTORY No. 9

H. N. , a 59 year old male with no past pulmonary history was admitted with a diagnosis of possible heart infarct.

Hospital examination revealed a patient complaining of severe pain in the heart area. He had extreme difficulty in speaking and breathing.

Local Status: Thorax. There was absence of breath sounds over the left lung which was tympanic to percussion. The heart tones, rate and rhythm were normal. The blood pressure and E. K. G. were also normal.

Diagnosis: X-ray showed that the upper left lobe was completely collapsed. The right lung was highly emphysematous.

Therapy: An intercostal catheter was introduced immediately and 900 cc. of bloody fluid was removed. The lung expanded completely. Cultures of sputum and chest fluids for tuberculosis were negative. A week and a half later a

bronchoscopic examination was performed and proved negative. The patient was discharged after two weeks of hospitalization with the diagnosis of a broken emphysematous bulla.

Discharge Status: Final x-rays showed complete expansion. The patient's condition was good.

CASE HISTORY No. 10

H.R. , a 21 year old male with no past pulmonary history, while doing his daily exercise, felt a sudden sticking pain in the left shoulder blade. Dyspnea commenced shortly after.

Hospital examination revealed a well developed young male in no acute distress. Cyanosis and pain were also absent.

Local Status: Thorax. Percussion revealed a hyper resonance over the whole left lung. Breath sounds here were not audible.

Diagnosis: X-ray revealed a massive pneumothorax of the left lung. The mediastinum was greatly displaced towards the right.

Therapy: The pleural space was immediately tapped and an intercostal catheter was inserted. After a week, the lung did not expand and the patient was taken to surgery. Upon opening the thorax, the whole left lung was seen to be completely collapsed and it was covered with fibrinous clots. This area was bathed in a great deal of exsudative fluid and there were numerous adhesions to the chest wall. There were no signs of emphysema. The reason why the lung could not expand was because of these thickened adhesions. The fluid was drained out and the adhesions were carefully removed. Under positive pressure, the lung was again completely expanded and no air could be detected escaping. The pleural tear had obviously healed or had been closed off by the exsudative process. Immediately after the operative process, the patient felt much better. The x-rays showed that the lung was almost completely expanded but there remained a few small fleck like areas which were probably due to atelectasis or pleural thickenings. Seventeen days after the operation, the patient was discharged.

Discharge Status: The final x-ray showed these fleck like areas, however the patient was otherwise completely free of symptoms.

CASE HISTORY No. 11

E. G. , a 25 year old male was admitted with the diagnosis of chronic spontaneous pneumothorax. The patient's past history revealed that in the previous year, he had a pneumothorax in the right lung which after six weeks of bed rest had re-expanded. Since then the patient was sick on and off with bronchitis, angina, and rhinitis. The x-ray taken at this time showed the lung was again expanded. Six months later the patient, early one morning felt a sticking pain in his chest, and became extremely dyspneic, with cyanosis of the face. The patient was then hospitalized.

Local Status: Thorax. Inspection revealed decreased expansion on the right side. Percussion and auscultation showed a hyper resonance and decreased breath sounds over the whole right lung.

Diagnosis: X-ray revealed that the whole right lung was collapsed.

Therapy: After a trial period of eleven days with conservative therapy, operative treatment was employed. Upon opening the chest wall, it was seen that the apical dorsal region of the upper right lobe was covered with numerous emphysematous bulla. These bulla were hazel nut size. The area was sutured over and the adhesions to the chest wall were severed. Penicillin and streptomycin were injected into the pleural space. An intercostal catheter was placed in the anterior axillary line, and the chest wall was closed. Three days after the operation a large pleural effusion developed, and the chest had to be tapped. The x-ray revealed a small plum sized area of atelectasis in the sutured over area. The patient was discharged eighteen days later.

Discharge Status: The final x-ray showed that the right upper lung was still not completely expanded and that some pleural effusion did remain. The patient expressed no complaints.

CASE HISTORY No. 12

H. S. , a 21 year old male, was admitted with a diagnosis of recurrent pneumothorax. Two and a half months prior to this admission the patient, for the first time, developed a left sided pneumothorax, which was expanded with just bed rest. Eight days previous to this admission, the patient experienced while standing up, a sudden tension and pull within his chest. There was no pain or dyspnea, however there were heart palpitations. The patient was again placed in bed and remained there with no sign of improvement.

Hospital examination showed that the patient was in good physical condition with no cyanosis, dyspnea or complaints.

Local Status: Lung excursions on both sides were normal and equal while percussion revealed hyper resonance over the left lung. The breath sounds on this side were weak and bronchial breathing was present.

Diagnosis: X-ray showed a total collapse of the left lung with a moderate mediastinal shift.

Therapy: A pleural tap was performed and one liter of air was removed, but the lung refused to expand. After a trial period of seven days, operative therapy was decided upon. A thoracotomy revealed a pneumothorax without exsudate. The upper lobe had several adhesions to the chest wall. These adhesions were severed between two clips. The apical segment of the upper lobe was indurated and a small group of emphysematous bulla was present. This pathological apical segment was sewn over. Two separate rubber drains were left in the lower left pleural space. These drains were attached to an underwater system, and suction was applied. After three days, x-ray revealed expansion of the lung. The drains were removed and 18 days after the operation, the patient was discharged.

Discharge Status: The final x-rays showed that the left diaphragm was one inch higher than the right. There was a small atelectatic area in the upper left segment which corresponded to the sewn over area. The patient's condition was good.

CASE HISTORY No. 13

O. A., a 53 year old male, was admitted with a previous history of spontaneous pneumothorax. Three years prior to admission the patient had a pneumothorax on the right side. He was treated conservatively and after nine weeks of bed rest, the lung expanded. Tuberculosis tests at this time proved negative. Two years later while straining at defecation, he provoked another pneumothorax, also on the right side. Again he was treated conservatively and remained in bed for eight weeks. Since this time, the patient does not indulge in strenuous activity. The present history began two weeks prior to admission. At this time, while at rest he developed another pneumothorax but now on the left side. He was treated conservatively for two weeks in his home and four weeks in the medical clinic without results.

Hospital examination revealed a large asthenic elderly male, extremely nervous, lying motionless in bed, afraid to breathe. There was no dyspnea.

Local Status: Thorax. The left thorax showed less expansion than the right. There was hyper resonance to percussion with decreased breath sounds and tactile fremitus.

Diagnosis: X-rays showed a complete collapse of the left lung.

Therapy: An operation was immediately performed and an old healed tuberculosis was discovered. The lung was blown up and submerged in a saline solution. Air was seen escaping from a series of small pea sized isolated emphysematous bulla on the lateral side of the lower lobe. Here two of these bulla had burst. This area was sutured over. Talc was placed over the visceral and parietal pleura. Two drains were left inside, and the thorax was closed. X-rays showed that the lung was completely expanded after three days. The drains were removed and penicillin and streptomycin were placed in this area. At this time, the patient developed an itch, probably due to penicillin sensitivity. Successive x-ray follow-ups showed the diaphragm on the left side was fixed, probably due to adhesions, and a small pneumothorax still remained over the tip of the upper lobe. The patient was discharged twenty days after the operation.

Discharge Status: The final x-rays showed that the lung had just about completely expanded. The patient still complained of various pains, however he had no difficulty in breathing.

CASE HISTORY No. 14

E. L., a 49 year old male, was admitted with no past pulmonary history. About a month previous to admission, the patient caught a cold and coughed frequently. A few weeks later while coughing, he suddenly became short of breath and felt a sticking pain in his chest. Shortly after this, the patient was hospitalized.

Hospital examination revealed a patient in good physical condition, however, slightly cyanotic around the lips and face, with shortness of breath.

Local Status: Thorax. Percussion and auscultation revealed hyper resonance with decreased breath sounds and decreased tactile fremitus on the right side.

Diagnosis: X-ray showed a complete pneumothorax on the right side.

Therapy: The patient was treated five weeks conservatively, at which time, several attempts were made to re-expand the lung. However, these attempts failed and the patient was brought to surgery. Upon opening the thorax, it was seen that the right upper lobe was completely collapsed, while the middle and lower lobes were normal. By inflating the lung under positive pressure, the apical segment expanded well, while the posterior segment showed an extensive area of emphysematous bulla with pleural adhesions. These adhesions were severed, and this defective area was sutured over with normal lung tissue. After inflating the lung again, the posterior segment showed no more traces of emphysema.

A drain was left inside and the chest closed. The x-ray at this time showed that the right lobe was still atelectatic and there was still some effusion present. The lung was tapped and the fluid was removed. Due to a hole in the drain, a large skin emphysema appeared, which slowly reabsorbed in time. Eleven days after the operation the patient was discharged.

Discharge Status: The final x-ray showed a completely expanded lung. The skin emphysema had reabsorbed. The patient felt completely well. Two years later an x-ray revealed a process in this same lobe. A bronchoscopic examination with a biopsy confirmed the diagnosis of a bronchiogenic carcinoma. A right sided pneumectomy was performed. At the site of the previously operated area (where the lung was sewn-over) a carcinoma had developed.

CASE HISTORY No. 15

H.H. , a 42 year old male with history of a previous pneumothorax on the left side, again complained of the same symptoms, however now on the right side.

Hospital examination revealed a patient in no acute distress, with no shortness of breath while at rest.

Local Status: Thorax. There were no audible breath sounds, the tactile fremitus was absent, and there was hyper resonance over the right lung.

Diagnosis: The x-ray at this time, and with the help of tomograms, revealed a spontaneous pneumothorax on the right side, with a lung infiltrate in the upper lobe of the left lung. A tentative diagnosis of pneumoconiosis was made. The lab data showed a high sedimentation rate while the sputum analysis for tuberculosis was negative. The Mantou and a guinea pig test also excluded a possible tuberculosis infection.

Therapy: Several attempts to expand the lung were made without success. After thirty-three days of conservative therapy, the patient was submitted to surgery. Upon opening the chest wall, the lung was seen to be completely collapsed. The visceral pleura was heavily covered with fibrinous exudate. The whole lung area was extremely indurated. There was an extensive pneumoconiotic change here and a local area containing several groups of cherry sized emphysematous bulla. Some of these had obviously ruptured. This area was reduced and sewn over. Under positive pressure the lung was re-expanded and no air escaped. Since a similar condition was present in the other lung, a resection was not considered. Penicillin was instilled in the pleural cavity and a drain was left there. The x-ray revealed a partial re-expansion of the lung with a hydrothorax. Two weeks later the patient was released in care of his family physician.

Discharge Status: The x-ray at this time still showed an incomplete expansion of the right lung with a moderate degree of pleural effusion. The patient however had no complaints.

In reviewing these fifteen cases of spontaneous pneumothorax treated at the Surgical University Clinic, Basel, from the years 1952 to 1958, six important facts can be pointed out. (See Table IV).

- (1) This condition affected approximately six males to every one female.
- (2) The incidence was consistently higher in the 20-40 year age group. Eight patients were 30 years or less, and two were between 31-40 years of age. The rest were over this age level.
- (3) The overwhelming pathology was in the right lung. (12:3)
- (4) The presence of a precipitating element such as exertion was not virtually present.
- (5) Relationship to tuberculosis did not exist.
- (6) The symptoms were more pronounced in the older age group. Our observations correspond to what has been recorded by Tysinger and Byron in three separate journals.

Another point which should be brought to attention is that the pneumothorax can reoccur in the same or in the opposite lung. The same observation has been reported separately by Baronofsky and Shefts. The former then came to adopt the principle of treating unilateral spontaneous pneumothorax bilaterally. On the other hand, Shefts takes the view that at least one lung should be operatively treated so as to prevent possible bilateral simultaneous collapse.

VI. Conclusions

It is worth while to try conservative treatment first, because good results were obtained in more than 60 % of the patients without having to submit them to an operative procedure. All the operations, which at this clinic were of the suture type, have been, in general, successful with good expansion and no deaths or major complications. However, one patient did develop cancer in the same area two years later.

This lapse of time is not at all exceptionally long for lung cancer to develop. (Ryan, Mayo Clinic). Cancer in this case might have been microscopically present at the time of treatment and may have even been the cause of the pneumothorax.

By comparing the operative findings with the reports found in the literature, we can say that the suture method secures rapid and good expansion without producing severe complications. Some of the other methods have decided disadvantages, such as producing severe pain, fever, pathological processes, like fibrothorax, granuloma, and embolic phenomena. Still other technics, for example, parietal pleurectomy, while being good methods, provide no special advantages. Since most of these technics are of a relatively recent nature, it may require several years and more experience in order to evaluate their effectiveness. On the other hand, this suture method has been used by Nissen as far back as 1944 with good results.

Table I. Results accumulated at the Surgical University Clinic.

CONSERVATIVE THERAPY

Patient According to Number	Degree of Expansion at Time of Discharge		Expansion Time (in Days)	Failure to Expand**	Complications
	Complete	Incomplete			
1	x		5		None
2	x		1		Thrombophlebitis
3	x		3		Hydrothorax
4				x	
5				x	
6	x		1		None
7				x	
8		x	7		None
9	x		6		Hydrothorax
10		x	4		None
11	x		1		None
12				x	
13				x	
14				x	
15				x	

TOTAL 15 6 2 (Ave.) 4 7 3 complications

* - These patients were treated with bed rest alone.

** - These patients were operated on. (See Table II)

Table II. Results Accumulated at the Surgical University Clinic

Patient According to Number	Degree of Expansion at Time of Discharge		Expansion Time in Days after Operation	Time Between Admission & Operation	Complications
	Complete	Incomplete			
1		x	6	11	Hydrothorax
2		x	1	10	Hydrothorax
3		x	1	33	Hydrothorax
4		x	3	7	None
5	x		3	42	None
6		x	6	15	None
7	x		11	4	Carcinoma *
Total	2	5	(Ave.) $4\frac{1}{2}$	(Ave.) 4	4 complications

* - two years later.

Table III. Contemporary Results.

CONSERVATIVE THERAPY

B. R. Bed Rest Only
 N. P. Needle Puncture
 Cath. Catheter

Author	Total No.	Patients treated with			Expansion Time in Days		
		B. R.	N. P.	Cath.	B. R.	N. P.	Cath.
Craft & Lowry	40	9	4	27	10.9	?	2.2
Albert A. Marangoni	80	49	6	25 *	29	30	1
Kirchor & Swartzel	35	27	-	5-3 *	27	-	?
Briggs & Others	71	45	16-4 *	6	34	22-29 *	3
Shefts, Gilpatrick & Others	58	11	18	29	21	21	1.5
		Average Time			24	25	2

*. with use of under water suction

Table IV. Contemporary Results

OPERATIVE THERAPY

Results as Compiled by	Total	Type of Therapy	No.	Expansion			Main Disadvantages
				*Time	Comp.	Inc.	
Baronofski		Mechanical Irritation	6	NA	6		None
		Talc Insufflation	4	NA	4		Fever, Talc Embolism, Granuloma
		Parietal Pleurectomy	15	NA	15		Membrane Formation
	26	Lobectomy & Segmental Resection	1	NA	1		Loss of Lung Tissue
Gaensler	7	Parietal Pleurectomy	7	1	7		None
Maxwell	23	Kaolin	23	25	23		Fever, Long Expansion Time
Beardsley	3	Pleural Scrub	3	14	2	1	Empyema, Hydrothorax
Brohm	12	Carbon Dioxide Infusion	12	1	10	2	Formation of Small Pneumothoraces as a Result of Nitrogen Trapping
Kallqvist	1	Varidase	1	7	1		Allergic Reaction, Fibrothorax
Shefts		Talc Insufflation	5	NA	5		Fever, Difficulty in Administering with Closed Thoracotomy
		Cyst & Bulla Resections	37	NA	37		Loss of Lung Tissue
		Glucose Instillation	11	NA	11		Severe Pain

* - The time is averaged in days, however in several cases the time was not available and in these cases the notation "NA" is used.

Table V. Results accumulated at the Surgical University Clinic

MISCELLANEOUS FACTORS

	Sex		Age	Side		Former Side		Symptoms prior to Lung Expansion (Age Group)		Persisting Symptoms after Expansion	Relation to -		
	M	F		R	L	R	L	Under 35 Years	Over 35 Years		TBC	Exertion	
(1)	x		25	x		x		Pain, Dyspnea, Cyanosis		None	No	No	
(2)	x		59		x				Dyspnea	None	No	No	
(3)	x		21		x			Pain, Dyspnea		None	No	No	
(4)		x	43	x					Cough, Pain, Dyspnea	None	No	No	
(5)	x		42	x			x		Dyspnea	None	No	No	
(6)	x		21		x		x	Dyspnea, Arrhythmia		None	No	No	
(7)		x	38	x					Cough, Dyspnea	Exertional Dyspnea	No	No	
(8)	x		53		x		x		Pain, Dyspnea	None	No	Yes	
(9)	x		21	x				Cyanosis, Dyspnea		None	No	Yes	
(10)	x		29	x				Cough, Pain, Dyspnea		None	No	No	
(11)	x		25	x				Pain, Dyspnea		None	No	No	
(12)	x		23	x				Pain		None	No	No	
(13)	x		30	x				Pain, Dyspnea, Cyanosis		None	No	No	
(14)	x		31	x				Pain, Dyspnea, Cyanosis		None	No	No	
(15)	x		49	x					Dyspnea, Cyanosis	Inspir. * Pain	No	No	
Total 13				11	4	3	2					0	3

* - Carcinoma developed in the same lung two years later

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Curriculum vitae

Name: Berger, Marvin
 Geburtsdatum: 19. Januar 1928, in Brooklyn, New York, USA
 Zivilstand: Ledig.

AUSBILDUNG:

1946 Graduated an der Erasmus Hall High School, Brooklyn, New York.
 1951 B. A. Brooklyn College, New York.

Seit September 1954 Medizinstudium an der Universität Fribourg.
 Februar 1956 anatomisch-physiologische Prüfung bestanden.

